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# **Towards a Blended Pedagogy: Learning inside and outside the classroom**

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## **Introduction**

This paper advocates a blended pedagogical approach as a strategy for improving the ability of science education to respond to the needs of current and future citizens faced with major challenges related to the environment and sustainability. The paper is organised into five sections: 1. What's the challenge?; 2. Interest or identity?; 3. What do museums, etc. offer?; 4. A blended pedagogy?; and, 5. Issues and ideas. The first section suggests that science education as it is often manifested in classrooms and laboratories is not meeting the needs of the majority of students who do not go on to study science at university or take up careers in science. The second section looks at evidence from a longitudinal research project (Aspires) which suggests that many students are being put off studying science not because they do not find science interesting but because of issues concerned with identity. The third section examines what institutions such as museums, science centres and botanic gardens might offer in terms of science education. The fourth section discusses some pedagogical approaches and techniques that school science education might borrow from elsewhere in terms of techniques for promoting learning outside the classroom. The final section identifies some potential challenges faced by science teachers, teacher educators and researchers.

## **1. What's the challenge?**

### *Wicked problems*

The challenges facing science educators have evolved as a number of highly complex problems have emerged. Unlike science problems which Rittel and Webber (1973) describe as 'tame', 'wicked problems' are difficult to define and have no straightforward solutions, perhaps no solutions at all. Rittel and Webber suggest that all we can do is look for 're-solutions' to these constantly evolving and morphing challenges. These issues, as I and colleagues have pointed out elsewhere, are becoming more urgent.

*Wicked problems have become more pressing with rising global temperatures and sea levels; rapid increases in loss of biodiversity, from deforestation and other forms of habitat destruction and degradation; depletion of natural resources; and contamination of drinking water. These kinds of environmental concerns are causing social and economic problems such as the displacement and forced migration of human populations vulnerable to the impact of climate change and conflicts over access to diminishing resources. These problems threaten to disrupt social and political stability on a global scale and lead to even greater inequality and*

*poverty because the poorest populations are the most vulnerable to these damaging ecological forces. (Dillon et al., 2016, p. 451)*

### *Existing science curriculum and pedagogy*

To what extent does the existing science curriculum prepare today's students to address these wicked problems? I cannot point to a country which has a science curriculum that addresses these issues adequately. Of course, one might argue that it's not about the curriculum, it's about the pedagogy – how people teach the existing curriculum. Teachers might address wicked problems as they teach their existing curriculum. So, perhaps, the answer would be to focus on the pedagogy as much as on the curriculum.

The evidence from around the world seems to suggest that the science curriculum tends to focus on the minority of students who are likely to choose science for further study and for a career in science (see, for example, Osborne & Dillon, 2008). However, this approach is flawed:

*The problem with framing the discussion about school science in terms of the supply of the next generation of scientists is that it defines the primary goal of science education as a pipeline, albeit leaky. In so doing, it places a responsibility on school science education that no other curriculum subject shares. Our view is that a science education for all can only be justified if it offers something of universal value for all rather than the minority who will become future scientists. For these reasons, the goal of science education must be, first and foremost, to offer an education that develops students' understanding both of the canon of scientific knowledge and of how science functions. In short that school science offers an education in science and not a form of pre-professional training. (Osborne & Dillon, 2008, p. 7)*

In *Science Education in Europe*, Jonathan Osborne and I identified some of the major challenges facing science education in terms of curriculum and pedagogy. There is a substantial body of research evidence which identifies the impact of the current approach on students.

*The ROSE study of students' attitudes to science in more than 20 countries has found that students' response to the statement 'I like school science better than other subjects' is increasingly negative the more developed the country [Figure 1]. Indeed, there is a 0.92 negative correlation between responses to this question and the UN Index of Human Development[6]. In short, the more advanced a country is, the less its young people are interested in the study of science. (Osborne & Dillon, 2008, p. 13)*

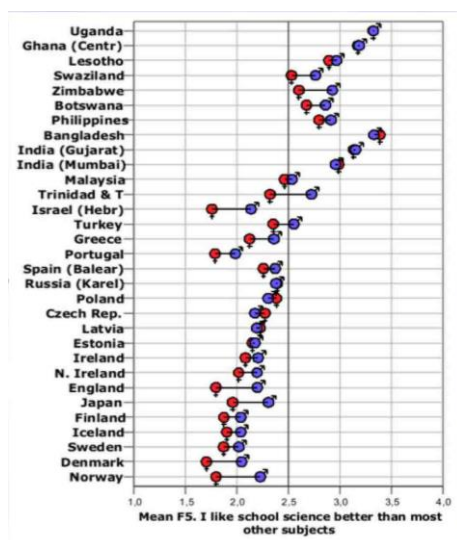


Figure 1: Data from the ROSE study showing students' responses to the question 'I like school science better than most other school subjects' (1 – strongly disagree, 4 – strongly agree; red symbols – female/blue symbols – male)

I have visited science classrooms across the world and found many similarities (see, for example, Figure 2). What I have not found is evidence that science teachers focus on helping students to examine their interests and identity in science rather their primary focus is on representing the subject matter of science to students. I would argue, however, that this is only one purpose of science education.



Figure 2: A chemistry classroom in Hiroshima, Japan

## 2. Interest or identity?

What, then, are the other purposes of science education and how might science education be improved? The conventional wisdom, on which many efforts to improve science education are based, is that it's all about getting more students

more interested in science by, for example, making it more relevant. However, the situation is more complicated than that.

*Whilst science and technology are often seen as interesting to young adolescents, such interest is not reflected in students' engagement with school science that fails to appeal to too many students. Girls, in particular, are less interested in school science and only a minority of girls pursue careers in physical science and engineering. The reasons for this state of affairs are complex but need to be addressed. (Osborne & Dillon, 2008, p. 15)*

The Aspires Project led by Louise Archer at King's College London has attempted to tease out some of the complexity of these issues. Aspires involved a longitudinal study of students from their final year in primary school (aged 10/11) to the end of the first key stage of secondary school (age 13/14) (Archer *et al.*, 2013). The key findings from the study include the observation that families exert a substantial influence on students' aspirations in terms of careers in and from science.

*This influence operates in many ways, but a key factor affecting the likelihood of a student aspiring to a science-related career by the age of 14 is the amount of 'science capital' a family has. Science capital refers to science-related qualifications, understanding, knowledge (about science and 'how it works'), interest and social contacts (e.g. knowing someone who works in a science-related job). Science capital is unevenly spread across societal groups. (Archer *et al.* 2013, p. 3)*

The evidence suggests that students possessing higher levels of science capital are more likely to be middle-class. Students in families who possess medium/high science capital 'are more likely to aspire to science and STEM-related careers and are more likely to plan to study science post-16' (*ibid.*). Importantly, the students aged 10 who possess low science capital and who do not express STEM related aspirations are unlikely at the age of 14 to develop STEM aspirations (*ibid.*).

These findings confirm that while interest in science is important, it is not the only issue. Many students who express high levels of interest in science may not choose science subjects because: a) they think that choosing science leads only to working in a laboratory; and, b) that science is for other people. These are issues of identity – of science and of the students themselves. So what can science educators do to help? The Aspires project suggests three courses of action:

1. Focus science engagement on young children;
2. Help students to realise that science opens doors;
3. Support students who want to do science – particularly, but not exclusively, girls.

The Aspires project attempted to influence policy through a series of publications, seminars and other events (see, for example Figure 3). This approach seems to have been successful.

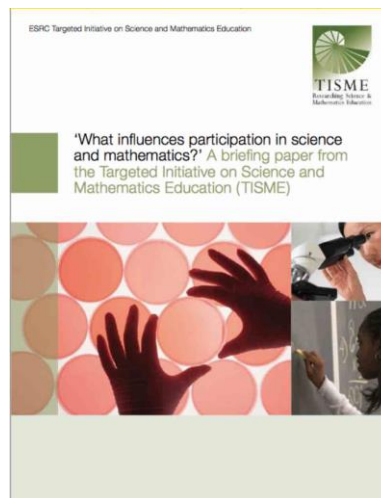


Figure 3: One of the Aspires project's publications aimed at policy-makers and practitioners

Much has been written about gender and science education. The importance of the images of science and scientists in influencing students has been recognised for decades. However, there are still many examples of gender stereotyping (see, for example, Figure 4).



Figure 4: An advertisement for a Danish science centre showing classic stereotypes of scientists

Figure 4 points to the fact that many students experience science outside school. One dimension of science capital is engagement with museums, science centres, botanical gardens, aquariums, etc. In the next section I will look at what museums, science centres, botanic gardens and aquaria offer in terms of engagement with science.

### 3. What do museums, etc. offer?

While research into science learning outside the classroom has provided many insights into what impact museums, science centres, etc. can have, there have been few studies into what pedagogic approaches might be transferable to the science classroom/laboratory.

While much of the pedagogy in school focuses on developing science process skills (for example, hypothesising, argumentation and observation), the pedagogy of science centres focuses on a different kind of engagement. Comparing school science and the science centre experience, in the latter context there is much more of a focus on the sensate: touching, hearing, moving, fearing, laughing and so on. The visitor to the science centre in Albuquerque, New Mexico, shown in Figure 5, is experiencing physical phenomena in an embodied way – I know because I tried it next. Schools do not have such equipment and yet they teach about centres of gravity, balanced forces, etc. Science centres provide excellent opportunities to develop understanding of core scientific ideas – they are not just places where people have fun.



Figure 5. A visitor on an exhibit in a science centre in Albuquerque, New Mexico

Science centres, museums, botanical gardens and aquariums provide opportunities for engaging with science in ways that reinforce, and in some ways, challenge the science that students learn, sometimes without understanding, in schools.

Comparing Figures 1 and 5, one is tempted to ask ‘What images of science do we want to encourage?’ Do we want to portray science as something special done by special people in special places or do we want to portray science as something ordinary done by ordinary people in ordinary places? My feeling is that this

question is key to understanding how science education might be reformed in the future.

We know from research that the impact of museums seems to be greater when visitors: a) can exercise control over what they do; b) have some choice of activities; c) are provided with some intellectual challenge; and, d) can collaborate with family or friends (Paris, 1998). I see great resonances between those findings and the findings of research into science learning in schools. This is one reason why I believe that there is much to be learned from looking at the pedagogy of museums, science centres, etc.

One final point, there are aspects of pedagogy in science centres and elsewhere that can be improved. One example is in the practices of science explainers who engage with visitors (see, for example, Figure 6). The evidence suggests that whereas science teachers focus on using questions to identify what science learners know and understand, explainers tend to focus on their ‘mini-scripts’ – passing on information (Kelsey & Dillon, 2010). That said, information is often what visitors want!



Figure 6: An explainer in the Blue Planet aquarium in Copenhagen, Denmark

#### **4. A blended pedagogy?**

Visitors can learn much from their experiences in science centres, museums, etc. What then might a blended pedagogy look like which would bring together the best of practice in teaching science inside and outside schools.

##### *A focus on specimens and display*

Museums, botanical gardens and aquariums share a focus on valuing objects. The object tells a story which may or may not require some interpretation through labels, audio-commentary or an explainer (see Figure 7). My feeling is that science teachers would benefit from training in finding, selecting and using objects in their lessons. Schools themselves might consider how they use their



spaces and their walls for learning. Some schools are quite sophisticated in this aspect but there is little research into the pedagogy of school space.



Figure 7: A visitor looking at an exhibit in the Blue Planet aquarium in Copenhagen, Denmark

### *Hands-on, brains-on*

As exemplified by the visitor to the science centre in Albuquerque mentioned above (Figure 5), museums and other institutions have the ability to present both hands-on and brains-on exhibits which are beyond the resources of most schools. The crustacean exhibit at the Blue Planet aquarium in Copenhagen, Denmark (Figure 8) involves visitors squeezing two handles together and then comparing the force of their grip with that of a lobster. This exhibit teaches about force and about animal adaptation elegantly and memorably. One wonders whether schools could adapt this approach to the teaching of science phenomena?



Figure 8: A visitor engaging with an exhibit in the Blue Planet aquarium in Copenhagen, Denmark

### *Growing food, growing minds*

The Edible Schoolyard (Figure 9) founded in 1995, is an excellent example of a pedagogic approach to teaching about food, farming and land management. Not all schools will have an acre (4,000 m<sup>2</sup>) of land to turn into a growing area, as the Martin Luther King Junior Middle School in Berkeley, California had, but the principle is transferable. Students can grow food crops in their school classrooms as well as outdoors. In my experience, more and more schools are turning part of their grounds into outdoor classrooms.



Figure 9: The Edible Schoolyard in Berkeley, California, USA

One of my favourite examples of a simple and innovative approach to teaching about where food comes from was devised by Michael Holland at the Chelsea Physic Garden. Michael's project 'Shelf Life' is a collection of plants growing in the packaging of the products which contain them. So, for example, as in Figure 10, a tomato plant grows in a tin of canned tomatoes and corn grows in a Dorito pack. This award-winning project illustrates how innovative pedagogical approaches do not need to involve lavish expenditure.



Figure 10. An example of innovative pedagogy at the Chelsea Physic Garden, London, England

*Whole-school approaches*

Some years ago I visited The Odyssey School of Denver in Colorado (Figure 11). The school's approach to education is based on a focus on the learning expedition – it is part of the Expeditionary Learning network. Students take part in a number of outdoor activities each year, gradually doing more challenging and residential activities.



Figure 11. The Odyssey School of Denver, Colorado, USA

The school utilises its spaces well and the quality of work that I saw students carrying out there was some of the best I have ever seen (see Figure 12). The vision of the school for its students is inspiring:

- Take risks and innovate;
- Lead with integrity and compassion;
- Be civically and socially engaged;
- Push themselves to exceed expectations; and
- Embrace learning as a life-long adventure.



Figure 12. A display in the Odyssey School in Denver, Colorado, USA

Closer to home, I've been deeply impressed by the Langley Academy which is not far from Heathrow Airport in England. The school has put museum learning at its heart and tries to integrate museum approaches into the curriculum. It has a marvellous building with an expansive atrium (Figure 13) that contains vehicles,

planes, boats and a model dinosaur. The floor had to be strengthened to take the weight of the large exhibits. Museum-quality display cases contain exhibits from museums as well as materials collected by the school. The leadership of the school support the excellent museum learning staff and encourage all teachers to utilise the museum learning approach.



Figure 13. The atrium in the Langley Academy, England

## 5. Issues and ideas

There are enough examples from around the world of innovative pedagogy ranging from the simple one-off ideas to whole-school approaches to make me confident that there is much to a blended approach to learning in science education. There are however, some challenges that the future offers.

One is the continuing prejudice and bias demonstrated in society generally and at the individual level. I was appalled by the young Einstein display at one of the show gardens at this year's Chelsea Flower Show. The Royal Horticultural Society does some fabulous education work so it is sad to see that there are some aspects of the organisation that embrace naïve and sexist educational approaches.



Figure 14. Young Einsteins at the Chelsea Flower Show, London, England

Finally, advances in information technology are in danger of making school science out-of-date. I am thinking particularly of immersive virtual reality

technology that will allow people to visit anywhere in the world and beyond. We don't understand how people learn with these technologies nor do we have the pedagogies to utilise them to their best advantages. If we do not invest in researching these technologies we will be doing a disservice to young people and to broader society.

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